“Trunk control in Adult Hemiplegia: Evaluating the effects of Dynamic Neuromuscular Stabilization and Neurodevelopment Therapy on Trunk Stability and Cardiopulmonary function”

SHORT SYNOPSIS

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Certificate

I hereby declare that the short synopsis "Trunk control in Adult Hemiplegia: Evaluating the effects of Dynamic Neuromuscular Stabilization and Neurodevelopment therapy on trunk stability and cardiopulmonary function" being submitted in partial fulfillment of the requirement for the degree of Doctor of Philosophy in Physiotherapy under faculty of Applied Sciences of Manav Rachna International Institute of Research & Studies, Faridabad during the academic year 2019. It is a bonafide record of original work carried out under the supervision of Dr. Ekta Chitkara and has not been submitted in full or part to any other university or institute for degree or diploma. Further, it is certified that short synopsis is plagiarism free and the proof has been submitted.

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ABSTRACT

Background/Introduction: Stroke or Cerebrovascular accident is one of main causes of mortality and disability in India. Common impairments include the positive and negative features of a UMN Syndrome affecting the trunk and extremities. Trunk impairment also causes problems with respiration, swallowing, and language. Following stroke, the physiotherapy treatment frequently relies on compensatory strategies. **Objectives:** This study will investigate the effects of two treatment approaches, Dynamic Neuromuscular Stabilization and Neurodevelopmental techniques on trunk stability and cardiopulmonary function in adult hemiplegics. **Method:** It will be a prospective experimental study comprising 60 subjects, who will be selected based on inclusion criteria and randomly allocated into two groups (n=30). Outcome variables will include the Modified Rankin Scale, Trunk Impairment Scale, Postural Assessment Scale for Stroke, Walking Ability, O2 Saturation, RHR, BP, RR. Group A will receive Neurodevelopmental therapy and stretching and Group B will receive Dynamic Neuromuscular Stabilization and stretching for 1 hour per day for 5days in a week for 6 weeks. **Results:** The expected result of the study will be that both the regimes will elicit significant improvements among all variables in a pre-post comparison and the DNS group will show improved cardiopulmonary function and the NDT group will show improved trunk stability.

Keywords: Stroke, Cerebrovascular Accident, Upper Motor Neuron syndrome (UMN Syndrome), Dynamic Neuromuscular Stabilization (DNS), Neuro-Developmental Therapy (NDT).

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1: Introduction

1.1 Definition, Epidemiology, and Impact of Stroke

Stroke or Cerebrovascular Accident (CVA) is the rapid onset of deterioration of neurological function of a person due to disruption of blood supply or rupture of a blood vessel of the brain. The clinical signs of neurological impairment must be present for at least a day to be defined as a Stroke. Motor impairments are characteristically seen affecting the contralateral side of the body with either Hemiplegia (Paralysis) or Hemiparesis (weakness). Hemiplegia is the common term used to define multitude of clinical problems associated with a stroke. "The location of lesion, total area of brain involved, the amount of collateral blood flow, and early acute care management determine the severity of neurological deficits in an individual patient" (O'Sullivan, 2014). "Stroke is a major cause of disability in adults, with 70–85% of first strokes having hemiplegia" (Dobkin, 2003). It was found that around 60% of people with hemiplegia who need inpatient rehabilitation have achieved functional independence in simple activities of daily living (ADL) such as toileting and walking short distances after six months following a stroke. (Patel, Duncan, Lai & Studenski, 2000), (Jorgensen, Nakayama, Raaschou, 1995).

The prevalence rate of stroke is (Banerjee, Mukherjee, Sarkhel, 2001) 147/100,000 with a yearly incidence rate of 36/100,000. Higher rates were observed in women than in men with 564/100,000 in women and 196/100,000 for men. Similar findings of incidence rate show 204/100,000 for women as compared to 36/100,000 for men. In all the stroke patients who were scanned for type of stroke, 68% were infarcts and 32 % of the strokes were hemorrhages. The compiled findings of prevalence studies show the range between 147-922/100,000 (Prasad, Vibha, Meenakshi, 2012), (Bharucha & Bharucha, 1988).

To assist developing countries in stroke surveillance, A stepwise approach (STEPS Stroke) utilizing standardized tools and methods for data collection (Bonita, Beaglehole, 2007) was defined by the World Health Organization. A study on stroke epidemiology was conducted in four cities using the 'WHO-STEPS Stroke protocol' in Mumbai,(Dalal , Malik , Bhattacharjee , Trivedi , Vairale , Bhat, 2008) Trivandrum,(Sridharan , Unnikrishnan , Sukumaran , Sylaja , Nayak , Sarma , 2009) Kolkata (Das , Banerjee , Biswas , Roy , Raut , Mukherjee , et al., 2007) and Bangalore (Nagaraja , Gururaj , Girish , Panda , Roy , Sarma, 2009). The findings showed a crude incidence of between 145-152 / 100,000 across the cities.

In developing countries like India, stroke leads to early mortality and permanent disability due to varied demography coupled with increasing incidence of modifiable risk factors. This along with low income causes burden on the amount spent by families on rehabilitation. (Bonita & Beaglehole, 2007) & (Pandian, Srikanth, Read &Thrift, 2007)

1.2 Impairment of Trunk Control in Stroke

"Trunk is described as the part of the body between the neck and the pelvis" (De Leva 1996). Effective trunk control maintains stability of the spine for the limbs to perform their task of mobility (Carmo, Kleiner, Costa & Barros, 2012) & (Cromwell, Aadland-Monahan, Nelson, Stern-Sylvestre & Seder, 2001). Stable trunk maintains the COG within the BOS while providing for controlled mobility and skillful walking. There is symmetrical loading and transfer of weight of the head, arms and trunk towards the lower limbs in both static as well as dynamic activities (Karthikbabu, Solomon, Manikandan, Rao, Chakrapani & Nayak, 2011). Trunk muscles also contribute to maintenance of balance while performing functional tasks (Ceccato, De Seze, Azevedo & Cazalets, 2009). During dynamic activity like walking, there is minimal shift of the trunk in multiplanar directions (Krebs, Wong, Jevesevar, Riley & Hodge, 1992). Hemiplegic subjects have abnormal trunk stability due to weakness of one half of the trunk which further leads to gait impairment (Balaban & Tok 2014). Stroke patients then compensate by increasing lateral trunk sway and by elevating affected side hip to clear the ground during swing phase of gait. Impairment is also seen in reciprocal arm movement in relation to trunk and pelvis owing to spasticity of affected upper limb and loss of recoil of trunk in relation to pelvis further increasing the energy expenditure during walking. This causes early fatigue in hemiplegic subjects. (Hacmon, Krasovsky, Lamontagne & Levin, 2012). Hacmon (2012) and Verheyden (2006) supported this by observing weakness in trunk muscles in subjects with unilateral stroke when compared with normal individuals. Following stroke, trunk impairment leads to loss of balance reactions. This can be ranging from decreased capacity to correct perturbations to complete loss of balance depending on extent and severity of neurological impairment. The normal side cannot compensate enough for the affected side as loading is impaired due to spasticity or weakness. In spasticity it is further deteriorated by the release of primitive reflexes hindering balance reactions from functioning. Further, spasticity, weakness, Hypertonicity, trunk control impairment and lack of coordination between trunk and limbs further leads to the evolution of abnormal postural reflexes (Bobath 1989), (Ryerson, Brown, Wong & Hidler, 2008) &

(Karatas,Cetin, Byramoglu & Dilek, 2004). Studies by Fujiwara (2001), Tsuji (2003) have also shown that there would be bilateral involvement of the trunk with weakness of flexor-extensor groups and rotator groups in stroke subjects when compared with normal subjects (Tanaka, 1997 & Tanaka, 1998).

The trunk comprising of the axial skeleton provides a stable support for the girdles on to which appendicular skeleton is attached. The movements in limbs are effectively generated by contraction of various muscles to produce meaningful action. This is possible when strong co-contraction of the trunk muscles maintains a stable spine. While maintaining its stability, trunk also has the maneuverability to move the Centre of Mass inside the total contact area of support. This task is a continuous fluidic task which continues even in static and dynamic activities while also maintaining vertical postures (Davis, 1990, Reyson, 1997, Edwards, 1996). In stroke, this maneuverability is lost due to impaired feed forward and feedback mechanisms required to prepare and correct the actions performed before and after attaining postures specifically in a dynamic task when observed by Electromyography (Dickstein,2004). Due to its importance in maintaining stability, Trunk control is a prerequisite to gain before mobility of limbs were to be achieved. Hence extent of impairment in trunk control can be understood to predict the outcome for functional activities after stroke (Duarte, Marco, Muniese, Belmonte, Diaz & Tejero, 2002), (Hsieh, Sheu, Hsueh & Wang, 2002) & (Verheyden, Nieuwboer, De Wit, Feys, Schuback & Baert, 2007). This is in conjunction with the findings of study by Messier (2004) who noted that in stroke, upper trunk compensates for impaired function of pelvis. Hence, movements in the trunk are initiated by the upper trunk and pelvis mobility is impaired with loss of anterior tilt required for movements. Hence it can be noted that trunk control is important in improving balance, symmetric loading and weight transfer., Limited studies have emphasized the role of trunk rehabilitation for patients with chronic stroke.

1.3 Impairment of Cardiopulmonary Function in Stroke

Following stroke, primary impairments due to neurological and musculoskeletal dysfunction further lead to, secondary impairments including cardiopulmonary, bowel and bladder, integumentary, nutritional, metabolic and endocrinal functions (Shaw, 1987). Pulmonary complications lead to problems in phonation, articulation, respiration, swallowing and language functions (Davies, Cooper & Fletcher, 1990). Weakness of the trunk muscles,

movement impairment which are further aided by impaired respiratory function lead to gait impairments and high energy expenditure in ambulation and early fatigue (Dean, 1993). Hemiplegic Patients will have impaired postural control due to trunk weakness and spasticity. Impaired balance and postural reflexes lead to fear of fall. The patient tends to reduce the effort for movement and gradually decrease the respiratory effort. Further, weakness of abdominals and chest muscles impair the respiratory function by reducing the excursion of chest required in ambulation. This along with non-use of the affected side lead to decrease in strength and endurance of respiratory muscles (Britto, Rezenden& Marinho, 2011 & Dickstein, 2004). Hence when the physiotherapy in initiated to improve aerobic tolerance, the patients easily tire and are unable to cope for changing demands of exercise easily (Lamini, 2003). Even when the patients return to community, trivial tasks like ADLs, Gait and simple functional tasks will become difficult (Reid, 1995). Therefore, treatment protocols for hemiplegic rehabilitation aiming to improve functional independence will not be sufficient to improve the cardiorespiratory function (Kelly, 2003). Hence treatment must also include protocols for improving cardiorespiratory function along with normal stroke rehabilitation which aims at sensorimotor function, Gait, etc. (Courbon, 2006). Most of the studies on cardiopulmonary function in stroke aimed at the trunk muscles, abdominal muscles highlighting their role in ambulation and balance. Diaphragm with its multiple roles as chief inspiratory muscle, stabilizer of trunk by regulating intra-abdominal pressure and as combination of both has to be studied. The diaphragm contracts along with abdominals to maintain the intra-abdominal pressure during breathing. Negative pressure in the thorax when diaphragm descent causes air to gush into the lung and when it relaxes in expiration, upward passive recoil leads to escape of air from lungs to out. Hence, the treatment must be aimed towards diaphragm and trunk muscles to improve cardiopulmonary function (Talasz, Kremser, Kofler, Kalchschmid, Lechleitner & Rudisch, 2011).

1.4 The Neuro-developmental Therapy Approach

Neuro-Developmental Therapy or Bobath approach is one of the most commonly used rehabilitation concepts for the treatment of cerebral palsy children and a regularly used model for adults with hemiplegia following stroke (Cherry & Knutson, 1993). The approach was developed on the concept that any pathology of the Central Nervous System will lead to impaired movement and posture due to abnormal muscle tone causing impairment in functions (K. Bobath & B. Bobath, 1984). The approach is based on the dynamic systems

theory of Bernstein (1967) who proposed that multiple systems of the CNS and Musculoskeletal systems works dynamically in regulating motor control. He proposed that in biological organisms' multiple systems work together in a complex fashion where all subsystems have equal roles in managing motor output. Components of the subsystems include muscles, joints, Lower and upper motor neurons, brainstem centers, cortical centers, etc. which function as one unit or synergy, the term he proposed for this is a "coordinative structure" (Zernicke and Schneider,1993). When movement occurs, changes in the pattern of movement are due to coordination between different aspects of the system including muscle recruitment, body mass, type of joint, posture adapted during the movement, mental status, environment around and synaptic firing between various pathways. In dynamic systems theory, these sub systems adapt and adopt to ever changing patterns and respond to produce meaningful response (Ulrich, 1997). Recent work by Edelman (1987) and Sporns (1994) has extended the dynamic theory by proposing that there is a balance between pattern generation and subsystems interacting to produce the pattern. Neuronal Group Selection Theory proposes that normal development of brain or recovery following a lesion occurs when the patient participates in functional tasks or according to ideal developmental level in coordination with the environment in which he is working to generate optimal movement for specific tasks.

NDT considers the development of broad sensorimotor experiences to be important in producing effective, a reliable movement that the individual can then select to achieve multiple functional outcomes. NDT intervention uses active movement, requiring the client to attend to the aim of the task to improve the ability to generalize on the link between movement and function. The approach utilizes facilitation of movements by guiding them by providing various cues using somatosensory, touch, and vestibular receptors to perform purposive actions of useful movement synergies in a task context. It also incorporates self-generated movements for solving motor problems to enhance motor learning and produce permanent changes in motor skills.

1.5 The Dynamic Neuromuscular Stabilization Approach

Dynamic Neuromuscular Stabilization (DNS) is a rehabilitation approach to improve stability and movement basing on kinesiological principles of normal development (Frank,

Kobesova & Kolar, 2013). DNS utilizes exercises based on ontogenetic developmental positions developed by Vojta (Kolar, 2013).

DNS proposes that movement patterns of a person are generally predetermined and are stored as muscle synergies in the brain. This neural control of motor behavior is responsible for controlling movement patterns, posture and locomotion. Repeated practice of functional motor tasks facilitates plasticity in the cerebral cortex. "The mechanism by which the nervous system responds to external stimuli and adjusts future responses based on previous outcomes, is defined as 'functional neural plasticity' and its understanding is fundamental in the field of neuromusculoskeletal rehabilitation" (Kolar, 2014). Maturation of the Nervous system aides in development of functional movement patterns appropriate for the age. This helps in the control of posture, enables locomotion and other skillful motor behavior. Any pathological lesion of the cortex inhibits this maturation process and cause abnormal modulation of inputs the cortex receives from the periphery. This may lead to disturbances in postural tone, weakness of the pelvic floor and spinal stabilizers (Kolar & Kobesova, 2014, Beck, 2009). It was found that 90% of outputs for the neuraxis and cortex modulation relay on ipsilateral Ponto medullary reticular formation. "Asymmetrical cortical output reflects clinically in the neuromusculoskeletal system with symptoms such as, decrease in muscle tone ipsilaterally, ipsilateral pain syndrome, generalized spinal stiffness and deconditioning syndrome" (Savic, et al., 1994. Nyberg-Hansen, 1965).

DNS utilizes the subconscious and synkinetic activation of deep core muscles (diaphragm, transversus abdominis, multifidus, and pelvic floor) and global muscles to generate the optimal intra-abdominal pressure (IAP) and associated entire up righting spinal stability (Liebenson, 2007).

2: Literature Review

2.1: Review of Literature on Trunk Control in Adult Hemiplegia

Titus, A.W., Hillier, S., Louw, Q.A., Inglis-Jassiem, G., (2018), in their cross-sectional pilot study on stroke subjects, analyzed kinematics of the trunk and parameters of gait. Eighteen stroke subjects between 2-50 months duration were studied. Videography and descriptive analysis were used as methods. Spatial Parameters included step length and stride length, Temporal parameters included walking speed, cadence, step time and stride time.

Trunk kinematics included trunk movements in three planes. The results show significant differences in spatiotemporal parameters and trunk kinematics between both sides of the body. The authors concluded that treatment must include trunk function tasks along with training of gait post-stroke.

Lee, H.J., Kang, T.W., Kim, B.R., (2018), in their study wanted to find out the effects of exercises of diaphragm and deep abdominal muscles (DDAME) on walking ability (WA) and balance ability (BA) in hemiplegic subjects. Ten subjects from the control group received traditional exercises and ten subjects of experimental group performed DDAME. Ten Meter walk test (10MWT) and Six-minute walk test were used to measure WA, Timed Up and Go test and Berg's balance scale were used to measure BA. The results showed improvements in within-group and between-group comparisons. The authors concluded that Diaphragm and Inspiratory muscle strengthening exercises as part of DDAME are effective in improving WA and BA in stroke patients.

Karthikbabu, S., Chakrapani, M., (2017), in their study tried to find out the reliability of hand-held dynamometer in quantifying the strength of trunk muscles, flexors, extensors, rotators and bilateral lateral flexors in chronic stroke subjects by break test. The results of their study showed good intra-rater and inter-rater of the device. From the findings, the authors concluded that Hand-held dynamometer can be used to quantify strength of trunk muscles in chronic stroke patients and the device can easily be administered in clinical and rehabilitation settings for diagnostic and prognostic purposes.

Hariharasudhan, R., Balamurugan, J., (2016), in their study, aimed to assess the clinical effectiveness of Physio Ball Exercises (PBE) and proprioceptive neuromuscular facilitation (PNF) technique to enhance trunk control in post-stroke subjects. Thirty hemiplegics with onset within 40 days of the stroke having ability to sit independently with or without arm support were recruited. Subjects were randomly grouped either into PBE group or PNF group, and outcome assessors involved in the study were blinded to allocation. The exercise program was administered for 4 weeks (30 min/day, 5 times/week). Trunk impairment scale (TIS) was used as the outcome variable. Both the treatment regimens were effective in improving trunk control. Between-group comparison yielded PBE to be more effective than PNF. The authors concluded that PBE was potentially effective for trunk rehabilitation of trunk among hemiplegic subjects.

Jung, K.S., Cho, H.Y., In, T.S., (2016), conducted their study to examine the effects of trunk exercises on trunk muscle activation, postural control, and gait speed in stroke patients when trunk exercises were performed on an unstable surface. Balance pad exercises were given to the experimental group for 30 min, 5 times per week for 4 weeks, trunk exercises on a stable surface were given to the control group for the same duration. Surface electromyography was used to measure activation of trunk muscles and, Trunk control was measured by Trunk Impairment Scale. Ten -Meter Walk Test (10MWT) was used to measure the Gait speed. Significant activity of the external and internal oblique muscles was seen in the experimental than in the control group and significantly greater improvements in TIS than did that of the control group. The 10 MWT score also showed improvements in the experimental group. The authors concluded that Trunk exercises performed on an unstable surface improve activation of trunk muscles, control posture, and speed of gait in patients with hemiplegic stroke.

Song, G.B., Park, E.C., (2015), in their study, examined the effectiveness two protocols, chest resistance (CREG) and chest expansion exercises (CEEG) on respiratory function and trunk control in stroke patients. Forty Patients without any preexisting pulmonary conditions before the onset of stroke were included. Forced vital capacity (FVC), and Forced Expiratory Volume (FEV1) were the measurement variables of pulmonary function and was used to measure the trunk control. Results of the study showed that both the groups showed significant changes in FVC, FEV1, and TIS post intervention in both the groups but non-significant results were seen in FVC and FEV1 when compared for between group differences. Trunk Impairment Scale significantly improved in the CREG after the intervention. The authors concluded that chest resistance exercises enhance respiratory muscle strength and endurance, which affect trunk stability in stroke subjects.

Liao, C.F., Liaw, L.J., Wang, R.Y., Su, F.C., Hsu, A.T., (2015), in their study, tried to find out the differences in trunk muscle activation between chronic stroke patients and normal subjects. Fifteen stroke patients were included in group A and 15 age- and gender-matched healthy subjects were included in the control group. Trunk flexion and Extension movements were performed and Symmetry index and cross-correlation of trunk muscles were measured. Trunk reposition error was measured to determine the activation asymmetry between groups. The authors found that symmetrical activation in internal oblique and cross-correlation of abdominal muscles of stroke patients were lower than control group. The authors concluded

that impairments were present in function of trunk muscles and Proprioception in chronic stroke patients.

Veerbeek, J. M., Wegen, E. V., (2014), in their systematic review and meta-analysis on the evidence of Physical Therapy post-stroke, collected literature on Randomized Control Trials (RCTs) using Neurodevelopmental Treatment (NDT/Bobath). The authors included 75 RCTs utilizing NDT as intervention. The literature was categorized based on type of intervention used. Thirty-Seven RCTs were comparing NDT with another intervention, 33 RCTs were comparing NDT with NDT plus other intervention and 6 RCTs were comparing NDT with Augmented NDT. Non-significant effects were found for improvements in strength between NDT and other interventions and Non favorable results were noted for improvements of Gait function, motor function, Upper limb activities and ADLs. Findings of literature for effects of NDT compared with NDT plus other intervention shows strong evidence for combination therapy over NDT on Muscle strength, Gait, ADLs, Balance and Upper limb activities. Literature for Comparison of NDT and Augmented NDT showed equal effects for both regimen on muscle strength, Gait and Upper limb activities.

Yu, S.H., Park, S.D., (2013), The authors studied the effects of core stability exercises on the trunk control and muscle activation in subjects with hemiplegic stroke. Twenty subjects were divided into two groups, Experimental group received core stability exercises and the control group were given standard exercise therapy for the muscles of the trunk. Treatment was given for 30 mins per session for 5 days a week for 4 weeks. Surface electromyography (SEM) was used to measure the activity and trunk impairment scale (TIS) was used for measuring stability of the core muscles. The results of the study showed non-significant differences between the groups for SEM, but, significant changes were noted in the TIS scores in the experimental group. The authors concluded that core stability exercises can be included for improving trunk function in hemiplegics.

Hsieh, C.L., Sheu, C.F., Hsueh, I.P., Wang, C.H., (2002), in their study assessed the correlation between trunk control and comprehensive Activities of Daily Living 6 months after stroke. One Hundred Sixty-nine stroke patients participated in this study. Trunk control were measured using Postural Assessment Scale for Stroke Patients (PASS-TC). Other predictor variables included were, age, gender, type of stroke, side of hemiparesis, urinary incontinence. Limb paresis using Fugl-Meyer motor test, balance using Fugl-Meyer balance

test, and basic ADL using Barthel Index were measured at 14 days post stroke. “It was concluded that concluded that PASS-TC score, age, Fugl-Meyer motor test score, and Barthel Index score were the strongest predictors of comprehensive ADL function”.

2.2: Review of Literature on Outcome Variables of the study

Banks, J.L., Marotta, C.A., (2007), this study was conducted to collect and assess the properties of the Modified Rankin Scale (mRS) and provide researchers who use the scale with pertinent evaluative information. The literature between 1957–2006 was chosen to search for articles in Medline about, structure, validity, scoring method, and the psychometric properties of the mRS and its utility in clinical trials. Fifty articles were included for assessment. The study found good test-re-test reliability. The authors concluded that there is good construct validity of the mRS for its correlation to physiological indicators such as type of stroke, size of lesion, perfusion of brain and neurological impairment.

Verheyden, G., Nieuwboer, A., Mertin, J., Preger, R., Kiekens, C., Weerdt, W.D., (2004), the study aimed to examine the clinometric characteristics of the Trunk Impairment Scale (TIS). Twenty-eight stroke patients were observed and scored by two physiotherapists. The reliability was between 0.62 - 1. percentage agreement was > 81%, Intraclass correlations (ICC) was between 0.85 - 0.99, Test /retest and inter-observer reliability for the TIS was between 0.96 - 0.99, Internal consistency were between 0.65 - 0.89, Content validity of TIS was well defined, Construct and concurrent validity were correlation with Barthel Index ($r = 0.86$) and the Trunk Control Test ($r = 0.83$). The study supported the use of the TIS in both clinical use and future stroke research.

Williams, L.S., Weinberger, M., Harris, L.E., Clark, D.O., Biller, J., (1999), This study tried to develop a reliable and valid stroke-specific quality of life (SS-QOL) scale for use in stroke subjects. Construct validity was assessed by comparing domains of SS-QOL with domains of established measures. Effect sizes was calculated for determining responsiveness, Internal reliability was excellent for the final 49-item scale. The authors concluded that SS_QOL is a valid and reliable tool for assessment of stroke specific quality of life.

Collin, C., Wade, D., (1990), in their study, compared the scores of Motricity Index (MI) and the Trunk Control Test (TCT), assessed at regular intervals after stroke with the River

mead Motor Assessment (RMA). The results showed that MI and TCT are easily administrated and quick, and strong correlation present between both. Statistics showed Good inter-rater reliability (0.76-0.88) and Good rank order comparison scores (0.70-0.79). strong positive correlation exists between the River mead Motor Assessment and the two short tests of motor function.

Carr, J.H., Shepherd, R.R., Nordholm, L., Lynne, D., (1985), the purpose of this article was to design Motor Assessment Scale (MAS) to measure the progress of stroke patients and to investigate the reliability of the scale in stroke patients. Results showed good intra-rater reliability with an overall average of 87 percent agreement. The authors concluded that MAS was highly reliable with high inter-rater average test-retest correlation.

3. Description of Broad Area of Research:
    1. Broad area of study defines all the strategies using explicit methods and implicit methods of treatment in stroke rehabilitation.
    2. Explicit methods refer to the learning of a novel task using external cues like verbal instruction, visual feedback, and tactile feedback, etc.
    3. Implicit methods refer to the learning of a novel task using internal cues from the subject himself. E.g.: corrections in posture, speed of movement, coordination, reaction time, etc.
    4. Dynamic neuromuscular stabilization and neurodevelopment therapy techniques will incorporate both explicit and implicit methods to treat hemiplegia subjects and the effects of the treatment will be quantified on trunk stability and cardiopulmonary system using various outcome variables.
4. Objectives of the study:
    a. To find out the effectiveness of Dynamic Neuromuscular Stabilization (DNS) and Neurodevelopment Therapy on trunk control and Cardiopulmonary function in subjects with hemiplegic stroke.
    b. To identify a better rehabilitation protocol between Dynamic Neuromuscular Stabilization and Neurodevelopment Therapy in improving stroke-related trunk and cardiopulmonary dysfunction.

5. Sample Size: G Power software was used to calculate the sample size and the following levels were used: (mean and SD of TIS was used to find the effect size)
    a. 2 Tailed study
    b. Effect Size – 0.8
    c. Probability of Error (α) – 0.05
    d. Power (1-β) – 0.85
    e. Allocation Ratio – N_1/N_2 – 1
    f. The total sample size calculated was 60 subjects who will be divided into two groups of 30 each (n=30).
6. Methodology:

SIXTY Subjects with hemiplegic stroke, without cognitive deficits, will be selected on basis of inclusion and exclusion criteria and will be randomly allocated into two groups

Group A (n=30) | Group B (n=30)

Pre-treatment reading of Modified Rankin Scale, Trunk Impairment Scale, Postural Assessment Scale for Stroke, Walking Ability, O2 Saturation, RHR, BP, RR will be taken

Neurodevelopmental techniques
1 hour daily/ 5 days a week/ 6 weeks

Dynamic Neuromuscular stabilization
1 hour daily/ 5 days a week/ 6 weeks

Post-treatment reading of Modified Rankin Scale (Disability), Trunk Impairment Scale, stroke-specific-QOL scale, Walking Ability, O2 Saturation, RHR, BP, RR will be taken.

Data will be compiled for Analysis

7. The expected outcome of the study:

1. Both studies may be effective in improving trunk control and cardiopulmonary function in a Pre-post condition.
2. As per available literature, Neurodevelopment Therapy techniques may significantly improve trunk stability in subjects with stroke.
3. Studies on Dynamic neuromuscular stabilization show that it may significantly improve cardiopulmonary function as it targets the diaphragm and pelvic floor.

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